Steam Reforming
of
Low-Level Mixed Waste

a oel e t e i aol o a
Willia teed a t e i aol o ill
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Introduction

e e a t e t o e is es o si le o t e t eat e t a d dis osal o a i ve to o a oxi atel to s o Low Level Mixed Waste LLMW Most o t is LLMW is sto ed i d s a els a d steel oxes at di e e t sites t o o t t e o lex e asi o e tive o low level ixed waste t eat e t s ste s is to o letel dest o t e a a do s o stit e ts a d to si lta eo sl isolate a d a t e t e adio lides i a sta le i al waste o s as lass so e i e ases adioisoto es s as a i a e ote tiall e ove ed o e le e e a t e t o e is s o so i t e develo e t o adva ed te olo ies t at eet t is o e tive w ile a ievi axi vol e ed tio ed ed low li e le osts a d axi o e atio al sa et e o e is i t e i al sta es o develo e t o a stea e o i s ste a a le o t eati a wide va iet o low level ixed waste t at eets t ese o e tives e desi o st tio a d testi o a o i al to da o ess evelo e t it o seve al s o ate wastes i l di a o test o a s o ate a d a i o ta i ated solid waste is des i ed

Objectives

isto i all ve ew a e ta le o tio s ave ee availa le o t e t eat e t o LLMW o e s ove t e sa et o i i e atio s ste s ave li ited t ei a li a ilit adva ed t eat e t s ste is eeded t at totall dest o s t e a a do s o o e ts i LLMW wit o t i i e atio a d od es a o lea a le i al waste o t at a e eadil a d sa el dis osed o at a li e sed low level ial site o i a o iate t e adioisoto es e ove ed o e le e e o e tea e o i ste ovides i e a a te isti s o eeti t ese

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esea s o so ed t e e a t e t o e s ede al e e olo e te de o t a t M wit e o e ld ol ia oad ol ia M
tele ax

o e tives o a a o o tio o t e LLMW t e stea e o i ea tio stea ea ts wit d o a o s i t e eed to edo i a tl od e a o o oxide a d d o e o o l alled s t esis as

e o e a d M ave o d ted exte sive ilot a d de o st atio s ale stea e o i tests o va io s waste ate ials i l di waste oil sewa e sl d e a e ill sl d e la li o e se de ived el a d a i lt al waste e e o e M ate ted stea e o i te olo is ei a lied o e iall to t e o essi o la li o i t e wo ld l a d a e i d st la li o is a a sti li id o tai i esi a d li i d o a o s a d sodi a o ate t e la li o a li atio t e d o a o s i t e li o a e o ve ted to s t esis as a d t e sodi a o ate is e ove ed o e se i t e a e a i o ess e a se o its a ilit to e ove a d o ve t d o a o s to s t esis as i l di alo e ated a d o alo e ated a a do s o o ds w ile isolati i o a i ate ial i l di t e adio lides o d i LLMW t e is s o so i a o a to de o st ate t e e o a e o t e e o e M stea e o i s ste o LLMW s o ates e ese tative o t ose o d i t e i ve to o tio de t e o t a t ovides o a detailed desi o a to l o it t at o ld e a i ated a d tested o a t al LLMW at a ose site

Project Description

de t e o t a t e o e a d its s o t a to s Ma a t i a d e olo o ve sio te atio al M e at ix to e We ste i ee i o o atio a d t e le so it i i atio esea La o ato a e to desi ild a d o e ate a o i al o d e da o ess evelo e t it a d to o d t exte sive tests o seve LLMW s o ate waste eeds to ve i a a do s o o e t dest tio a d t e isolatio a d a t e o adioisoto es lso solid i o a i ate ial o t e stea e o e test s will e i o o ated i to di e e t lass o latio s a d lea a ilit tests will e o d ted M is es o si le o o ess desi a i atio a d testi e at ix is t e s lie o t e la eless oxidi e a d as lea s s ste to e We ste i ee i is es o si le o st t al a d la o t desi a d le so it i i atio esea La o ato is es o si le o o d ti vit i i atio tests

e e o e M stea e o i s ste o t e t eat e t o LLMW is de i ted i *Figure 1* e o sists o t e ollowi a o s s ste s

- olid li id eedi s ste
- i st sta e l idi ed ed stea e o e wit i te al lo e
- ilte s o i es a t e
- la eless t e al oxidi e
- as lea o tai i
  - s a oole d s e
  - soda as a d wate sol tio eed s ste o s e
  - a o se a d ilte s
  - olis i wet s e

a tivated a o ilte
i d ed d a t a a d

- oile a d s e eate

e i st sta e stea e o e is a i di e tl eated l idi ed ed i a e a to li ed ea to vessel e l idi i edi is stea o s e io ixi a d eat t a s e to t e ate ial to e t eated le t i al eate s i e sed i t e ed ovide s le e tal eat as e i ed e ed te e at e is ve losel o t olled to e s e o lete volatili atio a d a tial stea e o i o all o a i o o ds a d to e s e ete tio o adio lides i l di esi o o ds i solid o alo wit ot e i o a i s i t e ed e i st sta e is o ti o sl ed waste ate ial si a Mo o s s ste o li ids a d sl d es a d o a ete ed s ew eed wit lo o e s o solid ate ial lass it o sa d is added to t e ed as eeded a d o lass it is also sed as t e sta t ed ate ial e i o a i s le t i t e ea to i l di adioa tive ate ial a e o ti o sl e oved o t e ea to a d o t e ilte s a d olle ted i sealed o tai e s Wit t e ex e tio o la e i o a i s t at a e i t e eed ate ial t e ed ate ial will e a o i al i o ea si e ate ial e i al waste o a e lass etal o a i i te it o tai e de e di o adiatio levels a d lea a ilit e i e e ts so e ases t e ed ate ial a d at ate ial o ld e o essed o e ove o adioisoto es s as a i

i te al lo e a d i te e at e e a i ilte s at t e exit o t e i st sta e stea e o e se ves to esse tiall eli i ate t e a ove o a ti lates i t e s t esis as st ea te a ti late e oval t e s t esis as lows i to a e at ix la eless t e al oxidi e is o i i e atio s ste o ve ts t e a o o oxide d o e a d d o a o va o s i to wate a d a o dioxide a d a id ases ased o exte sive testi de t is o t a t t e e o e stea e o i s ste as a ieved to o i i al a i a a do s o stit e ts s o d i wastes as lea s ste e oves a id ases as d salts ollowed a a tivated a o ilte as a i al olis i ste e ative ess e is ai tai ed t o o t t e e ti e s ste t e i d ed d a t a

e s o ate eedsto o latio s o t e i st six s o ates a e s ow i *Table 1* e o t a t was odi ied to o d t a o test o a seve t s o ate waste is waste is to e ese t as a atel as ossi le a a t al solid waste t at exists at a site e waste ose is a oil a d a i o ta i ated solid waste o d at t e o ts o t aseo s i sio la t e o latio o t is s o ate is s ow i a le

Accomplishments

e a atio o exte sive tests o s o ate ate ials i t e s ee i tests we e e o ed i a s alle stea e o e test it wit io ex a e esi s to a i e o e ati ex e ie e a d olle t eli i a data o e o a e o ex a e esi s a e a a to ea o t e six s o ate eedsto s e i i all t e o e tive was to dete i e ow well t e s o ate esi is etai ed i t e ed solids a d to dete i e t e o e t atio o s o ate esi i t e s t esis as st ea i a t t e e i i o t e test o ds o sili a sa d to i o s si e we e loaded i to t e ea to e ea to te e at es a d ess es we e

o ito ed to ve i sta le o e atio ixt o ds o do ed esi we e ed to t e stea e o e ove a e iod o a oxi atel ive o s e ea ed te e at e d i t e test was e lated to a o t total o o d o esi was ed a d a total o o d was olle ted ieldi e e t ass ala e is is s o t o t e e e t desi ed a d is d e to solids le t d ai ed i t e i st lo e di le e esi o e t atio i t e as sa les olle ted o t e sa li t ai was elow t e dete tio li it o a t e illio

e o st tio was o leted i late a d testi e a o t e six s o ates i e a esti was o leted i Ma e es lts o i ed o t e a a do s o a i o o ds a d isolatio o t e esi a d e i s o ates i t e solid etai ed t e ea to ed a d ilte s i a a se i t e s o ate testi s e t tilit io ex a e esi s we e s ess ll tested o a o e ial lie t to o i eedi vol e ed tio a d esi ete tio e solid ed ate ial o tai i t e e i a d esi was vit i ied a d s e ted to L e tests o i ed a o lea a le a d sta le i al waste o s a a t o t e o t a t a a d a i o ta i ated waste de i ted i a le was ide ti ied o a o test t t e o l sio o o s o ve satis a to testi t e test was sto ed e a se all o e tives ad ee a ieved was o i ed o t e o o lo o e e e ei sed o a d t e e i a i s o ate ete tio ad ee o i ed t is elt t at t ese va ied a ai s o ve s ess l s o ate tests ave i deed o i ed t e te i al via ilit o t e e o e stea e o i s ste o e e tivel t eati low level ixed waste

Future Activities

xte sive a al sis o t e e e tl o leted tests is ei o d ted as well as a eli i a desi a d ost esti ate o a o i al l o it t at wo ld o e ate o low level ixed waste s as t at at t e o ts o t aseo s i sio la t ollow o e o ts i l de detailed desi o a stea e o i s ste o testi o adioa tive ate ial at a site

Acknowledgments

e o e wis es to a owled e a d t a t e ex e tio al s o t o its s o t a to s M o ess desi a i atio a d testi to e We ste i ee i st t al desi a d te i al s o t e at ix la eless oxidi e a d t e le so it i i atio esea La o ato vit i i atio tests o ed i o a i s s e ial t a o to t e M s li a e te a d ill e e e iod o e o a e o t is o t a t is e to e e e wit a exte sio to Ma ei e ested

Low Level Mixed Waste

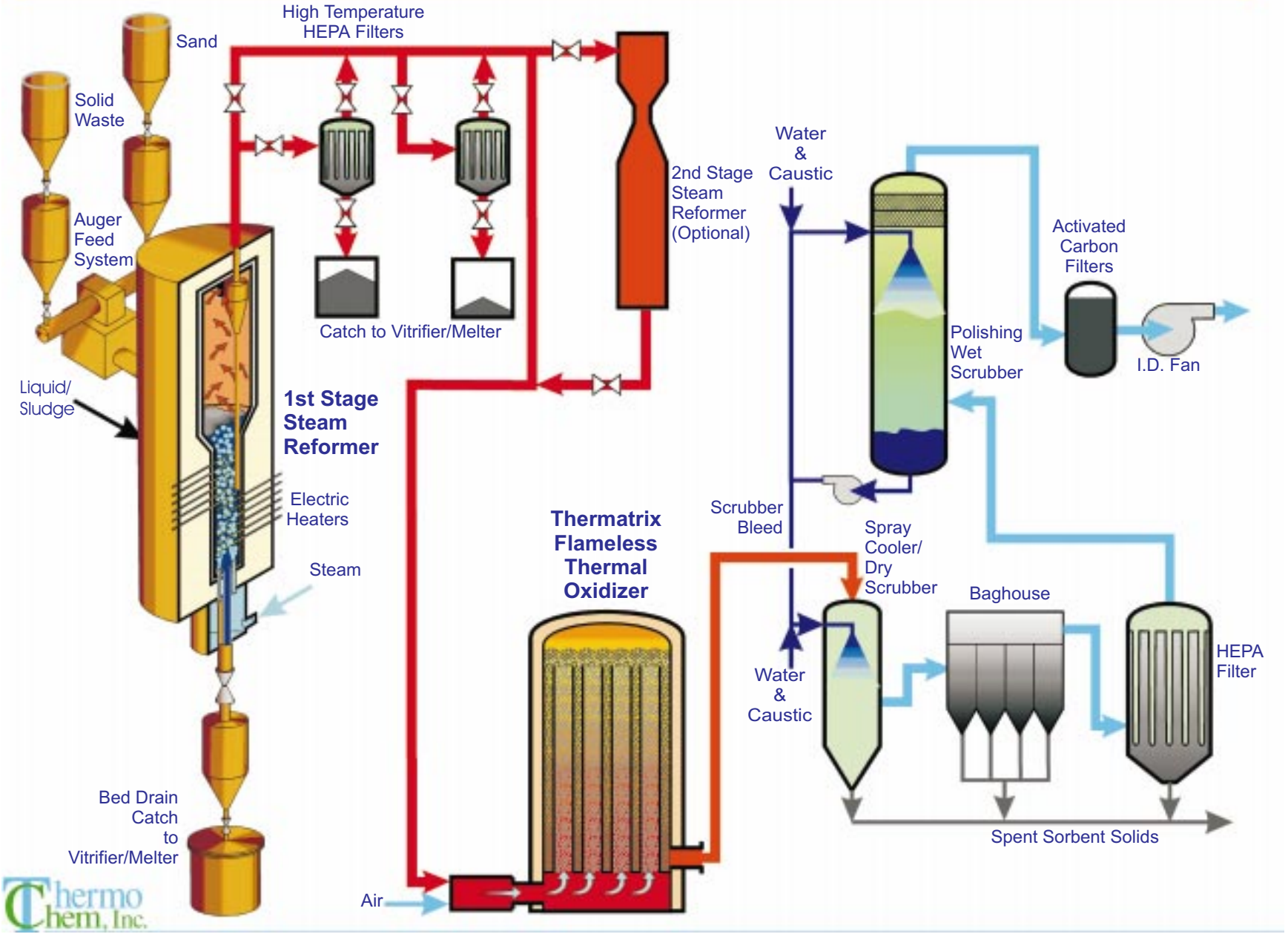

Figure 1: Thermochem/MTCI Steam–Reforming System for Treatment of Low–Level Mixed Waste

TABLE 1:
SURROGATE FORMULATION - SUMMARY

Number / Component	Heterogeneous Debris	Aqueous Halogenated Organic Liquids	Absorbed Aqueous Organic Liquids	High Organic Content Sludges	Cement, Sludges, Ashes & Solids	Natural Aqueous Wastes
	Wt.%	Wt.%	Wt.%	Wt.%	Wt.%	Wt.%
Bulk Ingredient 1. Activated Carbon	5.	5.	5.	10.	10.	5.
2. Cation Exchange Resin	5.	5.	5.	5.	5.	5.
3. Water	10.	10.	19.	15.	30.	75.
4. Wood	10.					
5. Polyvinylchloride (PVC)	10.					
6. Neoprene	10.					
7. Mild Steel / Hematite / Fe_2O_3	10.			10.	3.	
8. Glass Beads	10.					
9. Cement / Concrete	8.					
10. Alumina / Al_2O_3	10.			5.	2.	
11. Diatomaceous Earth	10.					
12. Toluene		10.				
13. Tetrachloroethylene		10.				
14. Mineral Oil		10.		7.		
15. Ethylene Glycol		10.	10.	10.		
16. Vermiculite		19.	25.			
17. Perlite (SiO_4)			25.	10.	10.	
18. $CaSO_4 \bullet 2H_2O$ / Plaster of Paris				10.	3.	
19. Phenol				10.		
20. Fly Ash (ASTM Class F)					15.	1.
21. Concrete (cured, crushed, screened)					20.	
22. $CaCl_2$						3.

Number / Component	Heterogeneous Debris	Aqueous Halogenated Organic Liquids	Absorbed Aqueous Organic Liquids	High Organic Content Sludges	Cement, Sludges, Ashes & Solids	Natural Aqueous Wastes
	Wt.%	Wt.%	Wt.%	Wt.%	Wt.%	Wt.%
23. $NaHCO_3$ / $NaNO_3$ *						3.
24. $MgSO_4 \bullet 7H_2O$ / $Al(NO_3)_3$ *						3.
25. $Na_2HPO_4 \bullet 7H_2O$						3.
RCRA Metals 26. $Cr(NO_3)_2 \bullet 6H_2O$ (or oxide)	0.1	0.1	0.1	0.1	0.1	0.1
27. $Ni(NO_3)_2 \bullet 6H_2O$	0.1	0.1	0.1	0.1	0.1	0.1
28. $Pb(NO_3)_2$	0.1	0.1	0.1	0.1	0.1	0.1
29. $Cd(NO_3)_2 \bullet 4H_2O$	0.1	0.1	0.1	0.1	0.1	0.1
RCRA Organics 30. Naphthalene ($C_{10}H_8$)	0.5	10.	5.	2.	0.5	0.5
31. 1,2-Dichlorobenzene ($C_6H_4Cl_2$)	0.5	10.	5.	5.	0.5	0.5
Radionuclide Surrogate 32. $CeCl_3$	0.3	0.3	0.3	0.3	0.3	0.3
33. $CsCl$ / $CsNO_3$	0.3	0.3	0.3	0.3	0.3	0.3

* Suggested substitute for surrogate Feedstock No. 6 only.

TABLE 2:

PIKETON SURROGATE FEEDSTOCK COMPOSITION

	NOMINAL* (Weight %)	HIGH** (Weight %)
ol o le e		
L		
M L		
M L		
M		

Most o t e test d atio o s a oxi atel
o t test o s ea